

Section 4.13 FACTORS FOR CONVERTING THC EMISSION RATES TOG/ROG

This section describes the factors used in determining the fraction of total hydrocarbons (THC) that are comprised of total organic gases (TOG), reactive organic gases (ROG) and methane (CH₄). These factors are based on a memorandum entitled “Organic Gas Speciation Profiles” from Don McNerry, Chief of the Modeling and Meteorology Branch to Mark Carlock, Chief of the Motor Vehicle Analysis Branch.

4.13.1 Introduction

During exhaust or evaporative emissions testing conducted during the Federal Test Procedure (FTP), the hydrocarbon emissions are measured using a flame ionization detector (FID). The FID measures total hydrocarbons or compounds with hydrogen and carbon atoms only; carbonyls are not included in THC. This is reflected in the exhaust and evaporative emission rates, which are measurements of THC. TOG includes all organic gases emitted to the atmosphere. ROG is the fraction of TOG that is reactive and does not include compounds that are exempt from regulations, i.e., methane, ethane, and acetone. The fraction of TOG that is either THC or ROG is determined by examination of the speciation profiles.

4.13.2 Methodology

In EMFAC2000, there are 13 vehicle classes (Table 4.13-1) with each vehicle class having up to six emission processes: starting, running exhaust, hot soak, diurnal, resting loss and running loss emissions. Ideally, given sufficient speciation data, one could derive conversion factors that are vehicle class, emissions process and fuel (pre and post cleaner burning gas or clean diesel) dependent. However, because of insufficient data the conversion factors (Table 4.13-2) cover several vehicle classes and technology groups. For example, the THC to TOG equation for running exhaust emissions is assumed to be the same for both catalyst and non-catalyst equipped vehicles, and across all vehicle classes. This assumption results from the fact that speciation tests have not been performed on non-catalyst equipped vehicles, other than passenger cars or light-duty trucks. EMFAC2000, however, should be coded to allow for future changes in the conversion factors that may be specific to the vehicle class, emissions regime, emission process and fuel type. Further, the conversion factors should be coded at the regime level. In the future the model may be required to output of TOG/ROG/CH₄ emissions as a function of the emissions regime.

Additionally, the conversion factors shown in Table 4.13-2 are valid to 0.1* g/mi. THC. Below this value, the conversion factors can be unstable. The model is coded to generate the same conversion factors assuming 0.1 g/mi. for THC for emission rates below this level.

* This value was chosen after consulting with Paul Allen of the Planning and Technical Support Division

Table 4.13-1 Vehicle Classes in MFACC2000

Vehicle Class	Description			Weight Class
	Fuel	Code		
1	ALL	PC	PASSENGER CARS	ALL
2	ALL	T1	LIGHT-DUTY TRUCKS	0- 3750
3	ALL	T2	LIGHT-DUTY TRUCKS	3751- 5750
4	ALL	T3	MEDIUM-DUTY TRUCKS	5751- 8500
5	ALL	T4	LIGHT-HEAVY DUTY TRUCKS	8501-10000
6	ALL	T5	LIGHT-HEAVY DUTY TRUCKS	10001-14000
7	ALL	T6	MEDIUM-HEAVY DUTY TRUCKS	14001-33000
8	ALL	T7	HEAVY-HEAVY DUTY TRUCKS	33001-60000
9	ALL	T8	LINE-HAUL VEHICLES	60001+
10	DSL	UB	URBAN BUSES	ALL
11	ALL	MC	MOTORCYCLES	ALL
12	ALL	SB	SCHOOL BUSES	ALL
13	ALL	MH	MOTOR HOMES	ALL

Table 4.13-2 TOG/ROG/CH4 Conversion Factors

Vehicle Class	Fuel Code	Fuel Type	Technology Group	Emissions Process	Equation
1,2,3,4,5,6,7,8,9,11,12,13	Gasoline	Pre-Cleaner Burning Gas	Catalyst	Running Exhaust	$\text{TOG} = 0.00721572 + 1.04581 \cdot \text{THC} + 0.000596997 / (\text{THC}) - 0.000107319 / (\text{THC}^2)$ $\text{ROG} = \text{TOG} \{ 0.915753 - 0.0570135 / (\text{THC}) - 0.00469847 / (\text{THC}^2) + 0.0008465052 / (\text{THC}^3) \}$ $\text{CH}_4 = \text{TOG} \{ 0.0627696 + 0.0584035 / (\text{THC}) + 0.00476385 / (\text{THC}^2) - 0.000860145 / (\text{THC}^3) \}$
“ “	“ “	“ “	“ “	Starting	$\text{TOG} = 1.0324 \cdot \text{THC}$ $\text{ROG} = 0.9230 \cdot \text{TOG} = 0.95291 \cdot \text{THC}$ $\text{CH}_4 = 0.0624 \cdot \text{TOG} = 0.06442 \cdot \text{THC}$
“ “	“ “	“ “	“ “	Hot Soak	$\text{TOG} = 1.0026 \cdot \text{THC}$ $\text{ROG} = 1.0000 \cdot \text{TOG} = 1.0026 \cdot \text{THC}$ $\text{CH}_4 = 0.0000 \cdot \text{TOG} = 0.0000 \cdot \text{THC}$
“ “	“ “	“ “	“ “	Running Loss	$\text{TOG} = 1.0026 \cdot \text{THC}$ $\text{ROG} = 1.0000 \cdot \text{TOG} = 1.0026 \cdot \text{THC}$ $\text{CH}_4 = 0.0000 \cdot \text{TOG} = 0.0000 \cdot \text{THC}$
“ “	“ “	“ “	“ “	Diurnal	$\text{TOG} = 1.0380 \cdot \text{THC}$ $\text{ROG} = 1.0000 \cdot \text{TOG} = 1.0380 \cdot \text{THC}$ $\text{CH}_4 = 0.0000 \cdot \text{TOG} = 0.0000 \cdot \text{THC}$
“ “	“ “	“ “	“ “	Resting Loss	$\text{TOG} = 1.0380 \cdot \text{THC}$ $\text{ROG} = 1.0000 \cdot \text{TOG} = 1.0380 \cdot \text{THC}$ $\text{CH}_4 = 0.0000 \cdot \text{TOG} = 0.0000 \cdot \text{THC}$
1,2,3,4,5,6,7,8,9,11,12,13	Gasoline	Pre-Cleaner Burning Gas	Non - Catalyst	Running Exhaust	$\text{TOG} = 0.00721572 + 1.04581 \cdot \text{THC} + 0.000596997 / (\text{THC}) - 0.000107319 / (\text{THC}^2)$ $\text{ROG} = \text{TOG} \{ 0.915753 - 0.0570135 / (\text{THC}) - 0.00469847 / (\text{THC}^2) + 0.0008465052 / (\text{THC}^3) \}$ $\text{CH}_4 = \text{TOG} \{ 0.0627696 + 0.0584035 / (\text{THC}) + 0.00476385 / (\text{THC}^2) - 0.000860145 / (\text{THC}^3) \}$
“ “	“ “	“ “	“ “	Starting	$\text{TOG} = 1.0361 \cdot \text{THC}$ $\text{ROG} = 0.8957 \cdot \text{TOG} = 0.92803 \cdot \text{THC}$ $\text{CH}_4 = 0.0935 \cdot \text{TOG} = 0.09687 \cdot \text{THC}$
“ “	“ “	“ “	“ “	Hot Soak	$\text{TOG} = 1.0026 \cdot \text{THC}$ $\text{ROG} = 1.0000 \cdot \text{TOG} = 1.0026 \cdot \text{THC}$

					$CH_4 = 0.0000 * TOG = 0.0000 * THC$
“ “	“ “	“ “	“ “	Running Loss	$TOG = 1.0026 * THC$ $ROG = 1.0000 * TOG = 1.0026 * THC$ $CH_4 = 0.0000 * TOG = 0.0000 * THC$
“ “	“ “	“ “	“ “	Diurnal	$TOG = 1.0380 * THC$ $ROG = 1.0000 * TOG = 1.0380 * THC$ $CH_4 = 0.0000 * TOG = 0.0000 * THC$
“ “	“ “	“ “	“ “	Resting Loss	$TOG = 1.0380 * THC$ $ROG = 1.0000 * TOG = 1.0380 * THC$ $CH_4 = 0.0000 * TOG = 0.0000 * THC$
1,2,3,4,5,6,7,8,9,11,12,13	Gasoline	Cleaner Burning Gas	Catalyst	Running Exhaust	$TOG = 0.0115168 + 1.05894 * THC - 0.00129204 / (THC) + 5.66768E-05 / (THC^2)$ $ROG = TOG \{0.95015 - 0.105111 / (THC) + 0.012543 / (THC^2) - 0.000616031 / (THC^3)\}$ $CH_4 = TOG \{0.0356821 + 0.106396 / (THC) - 0.0125986 / (THC^2) - 0.000613197 / (THC^3)\}$
“ “	“ “	“ “	“ “	Starting	$TOG = 1.0641 * THC$ $ROG = 0.9366 * TOG = 0.99664 * THC$ $CH_4 = 0.0528 * TOG = 0.05618 * THC$
“ “	“ “	“ “	“ “	Hot Soak	$TOG = 1.0644 * THC$ $ROG = 1.0000 * TOG = 1.0644 * THC$ $CH_4 = 0.0000 * TOG = 0.0000 * THC$
“ “	“ “	“ “	“ “	Running Loss	$TOG = 1.0644 * THC$ $ROG = 1.0000 * TOG = 1.0644 * THC$ $CH_4 = 0.0000 * TOG = 0.0000 * THC$
“ “	“ “	“ “	“ “	Diurnal	$TOG = 1.1248 * THC$ $ROG = 1.0000 * TOG = 1.1248 * THC$ $CH_4 = 0.0000 * TOG = 0.0000 * THC$
“ “	“ “	“ “	“ “	Resting Loss	$TOG = 1.1248 * THC$ $ROG = 1.0000 * TOG = 1.1248 * THC$ $CH_4 = 0.0000 * TOG = 0.0000 * THC$
1,2,3,4,5,6,7,8,9,11,12,13	Gasoline	Cleaner Burning Gas	Non - Catalyst	Running Exhaust	$TOG = 0.0115168 + 1.05894 * THC - 0.00129204 / (THC) + 5.66768E-05 / (THC^2)$ $ROG = TOG \{0.95015 - 0.105111 / (THC) + 0.012543 / (THC^2) - 0.000616031 / (THC^3)\}$

					$CH_4 = TOG \{0.0356821 + 0.106396/(THC) - 0.0125986/(THC^2) - 0.000613197/(THC^3)\}$
“ “	“ “	“ “	“ “	Starting	$TOG = 1.0657 * THC$ $ROG = 0.9248 * TOG = 0.98556 * THC$ $CH_4 = 0.0649 * TOG = 0.06916 * THC$
“ “	“ “	“ “	“ “	Hot Soak	$TOG = 1.0644 * THC$ $ROG = 1.0000 * TOG = 1.0644 * THC$ $CH_4 = 0.0000 * TOG = 0.0000 * THC$
“ “	“ “	“ “	“ “	Running Loss	$TOG = 1.0644 * THC$ $ROG = 1.0000 * TOG = 1.0644 * THC$ $CH_4 = 0.0000 * TOG = 0.0000 * THC$
“ “	“ “	“ “	“ “	Diurnal	$TOG = 1.1248 * THC$ $ROG = 1.0000 * TOG = 1.1248 * THC$ $CH_4 = 0.0000 * TOG = 0.0000 * THC$
“ “	“ “	“ “	“ “	Resting Loss	$TOG = 1.1248 * THC$ $ROG = 1.0000 * TOG = 1.1248 * THC$ $CH_4 = 0.0000 * TOG = 0.0000 * THC$
1,2,3,4,5,6,7,8,9,10,11,12,13	Diesel	Pre – Clean Diesel	All	Running Exhaust	$TOG = 1.4417 * THC$ $ROG = 0.8784 * TOG = 1.26639 * THC$ $CH_4 = 0.0408 * TOG = 0.058821 * THC$
“ “	“ “	Clean Diesel	“ “	“ “	$TOG = 1.4417 * THC$ $ROG = 0.8784 * TOG = 1.26639 * THC$ $CH_4 = 0.0408 * TOG = 0.058821 * THC$